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eTiPs: A Rule-based Team Performance Prediction Model Prototype

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Abstract

Understanding human potentials in teams are crucial because having the right people in a team can impact team performance. However, to date, there is no consensus on the right composition of team members because team dynamism and its interrelated factors is complex to uncover. Therefore, this paper presents an implementation of a rule-based team performance prediction model prototype or known as eTiPs. This prototype was developed to predict team effectiveness based on four factors: prior academic achievement, personality types, personality diversity, and software development methodology. Three main components of the eTiPs consist of interface, rule-based inference engine, and database was developed to realise the prediction model. A tested and verified IF-THEN rules extracted from rough set technique were used as inference engine of the eTiPs prototype, thus increasing validity and reliability of eTiPs to determine team effectiveness. To assess the usefulness and ease of use of the eTiPs, a usability evaluation was carried out by 12 experts from academic and industrial domain. Results show that the eTiPs able to provide a useful tool for decision makers as early preventive mechanism to predict team effectiveness. Future works will incorporate the eTiPs with intelligent elements to improve decision making process.

Keywords: rule-based, prediction model, team effectivenesss, rough set

1. Introduction

Understanding human potentials in teams are crucial because having the right people in a team can impact team performance. Therefore, there is a need to explore and understand human potentials that can bind and motivate team members towards achieving high performance productivity. However, to date, there is no consensus on the right composition of team members because team dynamism and its interrelated factors are complex to uncover. Due to this problem, a team performance prediction model, eTiPs serves as a novel solution that can be used to predict team performance. eTiPs is a model which relies on the ability to predict performance of a team based on four main factors, which are prior academic achievements, personality types, personality diversity, and types of software methodology used by the teams.

The importance of choosing the right people for a team has long been recognised, but little research has been done using rough set techniques in rule-based prototype modelling. In addition, up to current research knowledge, no study has been carried out in developing a rule-based prototype based on the four key factors: prior academic

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achievement, personality types, personality diversity, and software development methodology. Therefore, this paper presents an implementation of a rule-based team performance prediction model prototype or known as eTiPs. The paper is organised in four sections. A brief overview of related work on rule-based prototypes is described in Section 2. Then, eTiPs implementation is described in Section 3. Usability results and discussion follow in Section 4 and conclusions are drawn in Section 5.

2. Related Works

Rule-based decision support systems have played an important role in facilitating decision makers in planning, designing, and making recommendation in their daily work decisions. These systems include selection of personnel for human resource management [1-2], selection of software methodology for project management [3], and selection of distributors in supply chain management [4]. The decision systems are able to increase consistency and fairness in decision making. In developing a rule-based system, it is common to seek knowledge from domain experts to interpret the rationality of the rules chosen. However, when there is difficulty getting an expert, other techniques such as data mining can be used to analyse, discover, and extract knowledge from a given dataset. The dataset is used to develop a prediction model which based on patterns of association amongst variables under investigation and subsequently, the model can be validated using a new dataset.

One data mining method is a rough sets technique. This technique is a useful knowledge acquisition tool [5], which is represented in the form of a set of rules. The rules specify relations with combination amongst predictor variables investigated with outcome variables. Rough sets produce rules in the form of an IF (condition) THEN (outcome) structure. When the condition part of a rule is satisfied, the rule is fired and the outcome part is executed. There are two methods in rule-based modelling: backward chaining and forward chaining [6]. Rules extracted from rough sets can be categorised as forward chaining. This is because the rough set technique is based on a data-driven process, which starts by reasoning from known data and proceeds forward with the outcome of data. In this study, rules generated from rough sets were used as an inference engine to develop the eTiPs prototype. The rules were verified and tested with available data in [7-9] and act as a knowledge base that contains the IF-THEN rules that are useful to facilitate decision-making in determining effective teams.

3. eTiPs Prototype Implementation

The prototype was developed using Java Servlet Pages (JSP) technology with Netbeans as the programming editor, MySQL as the database management tool, and Macromedia Dreamweaver MX as the interface design tool. This prototype serves as an initial effort for predicting the team effectiveness based on prior academic achievements, members' personality types, personality diversity, and software development methodology. There are three important components in the prototype. The overview of the main components of this prototype is illustrated in Fig. 1.

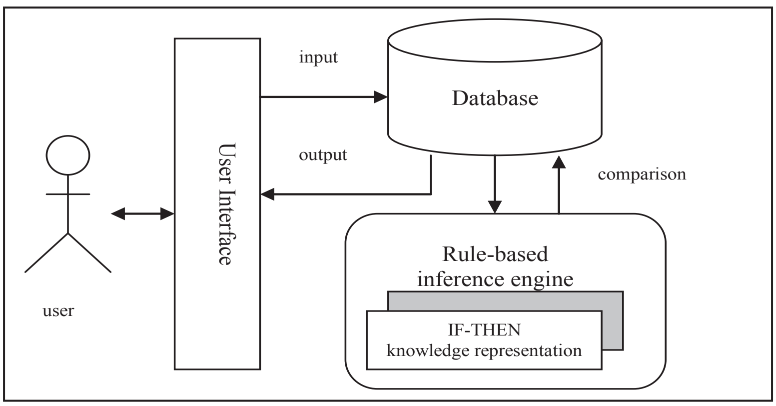

Fig. 1 Main components of the prototype

Details for each component are discussed in the following sub section.

3.1. User Interface

The user interface acts as a middleware that interacts between the user and the prototype. The user provides team information such as team number, team name, and team members as input through the user interface. Team information includes the type of software methodology used by the team, the members’ personality types, and the members’ prior academic achievement. Example of the eTiPs prototype interface is shown in Fig. 2.

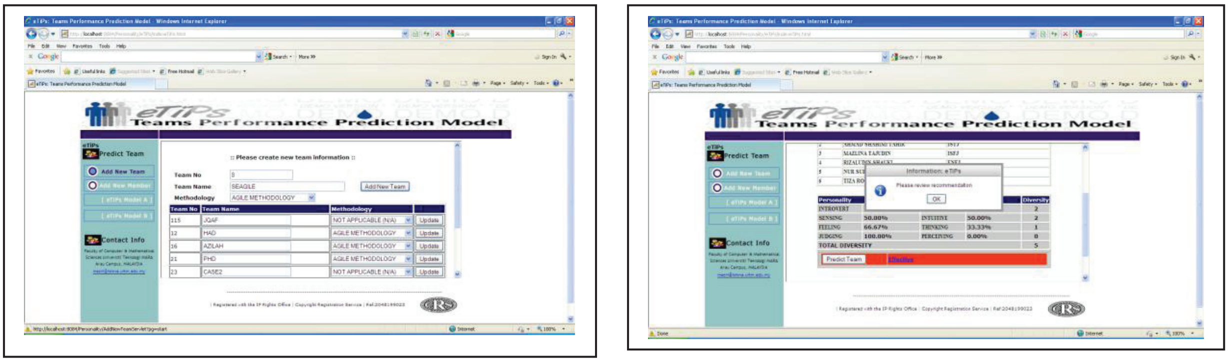

Fig. 2. (a) eTiPs interface to add team information ; (b) eTiPs interface to view prediction result

3.2. Inference Engine

The inference engine contains IF-THEN rules generated from the rough sets that were extracted as a rule-based inference engine. The rules were tested and verified using rough sets technique. These IF-THEN rules, which represent induced knowledge of the prediction model, were embedded into the prototype engine. The rules were coded using Java language. The inference engine was then used to determine and predict the team effectiveness.

In this study, there were two rule-based engines developed:

- eTiPs Model$_A$

This model predicts team effectiveness based on prior academic achievements, personality types, personality diversity, and software methodology.

- eTiPs Model$_B$

This model is more focused on industrial data sets with only two predictor variables: personality types and personality diversity.

3.3. Database

The database was MySQL, which stores information such as team information, provided by the user. The information was then compared with all related rules in the inference engine. From this comparison, the prototype automatically predicts the effectiveness of a team.

4. Usability Results and Discussion

To assess the usefulness of the prototype, a usability evaluation was conducted. A usability evaluation can be done with a minimum of five experts [10]. In this study, there were twelve experts participating in the usability evaluation. The experts include six people from the academic and six people from the industrial domains. All experts had more than five years experience in managing teams in academic and industrial settings. They included lecturers, executives, and managers in various fields such as information technology, engineering, and human resources management.

The evaluation was carried out by using a basic technology acceptance model (TAM) questionnaire adapted from [11], which is an accepted questionnaire in the information technology (IT) community. This questionnaire aimed to measure the perceived usefulness and ease of use of the eTiPs prototype. Measurement of the questionnaire was on a 7-point scale that ranged from 1 "extremely unlikely" to 7 "extremely likely". The questionnaire provided shorter items that could be easily understood and answered, and therefore were less time consuming.

Perceived usefulness measures the extent people believe that using a particular system can influence their job performance, and perceived ease of use measures the extent people believe that a system is free from effort [11]. The reliability and validity of this questionnaire has been verified and demonstrated in other studies [12-13]. During the evaluation, comments and feedbacks from the experts were sought.

The reliability of the questionnaire showed satisfactory internal consistency with Cronbach alpha, $\alpha = 0.82$ and 0.87 respectively for perceived usefulness and perceived ease of use. Overall, the reliability of the questionnaire is Cronbach alpha, $\alpha = 0.92$. Quantitative analysis was carried out using descriptive analysis.

From the perspective of perceived usefulness (Table 1), the experts found that the eTiPs prototype was able to make their job easier in terms of managing teams (M=6.33, SD=0.78), and thus enhance their job effectiveness (M=6.25, SD=0.62). Using eTiPs will improve their job performance (M=6.17, SD=0.72), support their tasks quickly (M=6.08, SD=0.67) and improve productivity (M=6.08, SD=0.67). Thus, they found that eTiPs is very useful in their job (M=6.00, SD=0.60).

Table 1: Descriptive statistics for Perceived Usefulness Scales

Perceived Usefulness Scales	N	Mean, *M*	Standard Deviation, *SD*
Accomplish tasks more quickly	12	6.08	0.67
Improve job performance	12	6.17	0.72
Increase job productivity	12	6.08	0.67
Enhance job effectiveness	12	6.25	0.62
Easier to do job	12	6.33	0.78
Useful in job	12	6.00	0.60

From the perspective of ease of use (Table 2), the experts found that the eTiPs was easy and flexible to interact with (M=6.25, SD=0.62), easy to use (M=6.17, SD=0.84) and to learn (M=6.17, SD=0.94). In addition, the prototype was also easy for them to become skillful in using (M=6.08, SD=1.00), easy to get it to do what they wanted (M=6.00, SD=0.60), and provided clear and understandable interaction (M=5.83, SD=0.72). Table 2 shows descriptive statistics for perceived ease of use scales.

Table 2: Descriptive statistics for Perceived Ease of Use Scales

Perceived Ease of Use Scales	N	Mean, *M*	Standard Deviation, *SD*
Easy to learn	12	6.17	0.94
Easy to get what is wanted	12	6.00	0.60
Clear and understandable interaction	12	5.83	0.72
Flexible to interact with	12	6.25	0.62
Easy to become skillful	12	6.08	1.00
Easy to use	12	6.17	0.84

The overall result of usability evaluation is presented in Table 3.

Table 3: Descriptive statistics for usability evaluation

Usability Scales	N	Mean, *M* (Percentage score)	Standard Deviation, *SD*
Perceived usefulness	12	36.92 (87.90%)	2.94
Perceived ease of use	12	36.50 (86.90%)	3.72

The results show that usefulness of the eTiPs prototype is higher than its ease of use. This indicates that eTiPs prototype is able to provide useful tool for assisting decision makers to determine effectiveness of a team. Feedback from the experts signified that the prototype met basic criteria for predicting team effectiveness. All of the experts appreciated that the prototype could assist them in future decision making, but suggested that it should provide extra information such as reasons why a team is effective or ineffective. To achieve this, future work should focus in integrating an intelligent element into the system.

5. Conclusion

The use of rough set rules provides a practical approach in developing a rule-based decision system. The eTiPs prototype can assist human resources managers, organisation leaders, politicians, and counsellors to make informed decisions, thus improving the effectiveness of teams' dynamism in organisations. The prediction results provide recommendations for decision makers by acting as an early preventive mechanism by guiding managers away from assigning the wrong type of individuals to specific tasks. This ability helps to improve and strengthen the human capital development of a nation. By predicting the right team composition, it is hoped that this prototype model can provide a practical mechanism for to create highly talented and skilled teams to elevate the nation to a more advanced economy.

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